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RELATION BETWEEN SOIL PROPERTIES AND AVAILABLE MICRONUTRIENTS IN SOIL

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ABSTRACT

The study was conducted in soils of Salem district of Tamil Nadu to understand the relation between soil properties and micronutrients availability. Totally 1691soil samples were collected @ 4 samples per village covering 385 panchayat villages in 20 blocks of Salem district. Samples were analysed to understand the soil properties and available micronutrients status. The database on the analysis of soil available micronutrients was developed using Microsoft Excel. The inter relationship between available micronutrients and soil properties were worked out through simple correlation analysis. Results showed that Soil reaction (pH) was significantly and positively related with B, significantly and negatively related with Fe, Mn and Zn where as non significantly and negatively related with Cu. Electrical conductivity was significantly and positively related with Fe and B and negatively related with Zn, Mn and Cu. Organic carbon showed a significant positive relation with Mn while non significantly positively related with Fe, Zn and B and non significantly negatively correlated with Cu. Free calcium carbonate showed significant negative correlation with Fe, Mn and B, and non significantly negatively correlated with Zn. However significant positive correlation existed with Cu.

KEYWORDS: Correlation, Soil Properties, Micronutrients

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Original Article

INTRODUCTION

Salem district is bound on the North by Dharmapuri district, on the South by Namakkal and Erode districts, the Western Ghats in the West and Villupuram district in the East. The district is having North Latitude between 11^0 14` and $12^0$ 53` and East Longitude between 77^0 44` and $78^0$ 50`. The geographical area of the district is 5,20,134 ha. The land use pattern in Salem district revealed that the net area sown and gross cultivated area is nearly 40 and 45.4 per cent of the total geographical area respectively.

Micronutrient fertilization is as important as macronutrient fertilization even though these elements are required in very small amounts for growth and development of plants. It plays a major role in plant's metabolic activities. And the deficiency may lead to decreased production and low quality products. Deficiency in plant may occur due to its low content in soil or due to the unavailability even though they are present in soil. The availability of nutrients in soil depends on many soil properties also. So before fertilizer application we should have an idea about the soil properties. The present investigation was undertaken to evaluate the status and distribution of micronutrients and their relationship with soil properties.

MATERIALS AND METHODS

Salem district falls under North Western Zone under the agro climatic zone classification. Under the agro Ecological Region / Sub Region (ICAR classification), it falls under Eastern Ghats and Tamil Nadu Uplands and Dry Region. There are fifteen established soil series in this district and out of these, Irugur series accounts for major area of 1,53,069 ha. The district comprises of twenty blocks viz., Salem, Veerapandi, Panamarathupatti, Ayodhiyapattinam, Valapady, Yercaud, Kolathur, Nangavalli, Mecheri, Omalur, Taramangalam, Kadaiyampatti, Attur, Peddanaickenpalayam, Talaivasal, Gangavalli, Sangagiri, Macdonalds Choultry, Idappadi and Konganapuram with 385 Panchayat villages.

The geo-referenced surface soil samples were collected from the Panchayat villages of Salem district to understand the relation between available sulphur and micronutrients with soil properties. Soil samples were collected @ 4 numbers per Panchayat village randomly at 0-15 cm depth by adopting the standard procedures of soil sample collection. Totally 1691 samples were collected. The collected soil samples were air dried, gently bound, sieved (2 mm sieve) and preserved in serially labeled polythene bags for further analysis. The surface soil samples were analyzed for various soil properties such as pH and EC (Jackson, 1973), organic carbon (Walkley and Black, 1934) and free calcium carbonate (Piper, 1966). The DTPA extractable zinc, iron, manganese, and copper were estimated using Atomic Absorption Spectrometer (Lindsay and Norvell, 1978). The available B status of the soil was estimated using hot water as extractant (Berger and Troug, 1946). Block wise soil analysis was done. The database on the analysis of soil available micronutrients was developed using Microsoft Excel. The inter relationship between available micronutrients and soil properties were worked out through simple correlation analysis.

RESULTS AND DISCUSSIONS

Soil Properties

The overall soil reaction (pH) of Salem district ranged from 5.39 to 8.86 with a mean of 7.97 indicating that the soils are acidic to alkaline in nature. The mean values of the pH of all the blocks revealed that soil is alkaline in condition. The lowest soil pH (5.39) was noticed in the soils of Yercaud block and this might be attributed to the impact of parent material (granite and sandstone) and leaching down of basic cations in soils by heavy rainfall during monsoon (Mini *et al*., 2007). The electrical conductivity (EC) of the soils varied from 0.05 to 2.74 dS m^{-1} with a mean of 0.24 dS m^{-1}. The low EC in these soils might be due to proper management of soil and by the leaching of salts from surface to subsurface and also due to the application of acidulating fertilizers in salt affected areas (Vijayakumar *et al*., 2011).

The organic carbon (OC) content in the soils ranged from 1.4 to 6.8 g kg^{-1} with a mean of 3.1 g kg^{-1} indicating that the soils were mostly low in OC status. The mean values of OC in the soils of all the blocks is low (< 5.0 g kg^{-1}). Under hyper-thermic temperature regime conditions, organic matter decomposition will be high which leads to low OC content in soil (Kameriya, 1995; Vijayakumar *et al.,* 2011). Table 1 shows the analytical details of soil properties. The highest mean OC content was registered in Talaivasal and Salem blocks (3.8 g kg^{-1}) followed by Gangavalli block (3.6 g kg^{-1}) and the lowest value was observed in Valapady block (2.5 g kg^{-1}). The free $CaCO_3$ values ranged from 1.0 to 15 per cent, indicating that the soils were non-calcareous to moderately calcareous in nature with mean of 6.9 per cent. Lowest value of 1.0 per cent was registered in soils under Yercaud block.

Available Micronutrients Content

The available Fe content in the soils of Salem district ranged from 0.9 to 82.2 mg kg^{-1} with a mean of 14.3 mg kg^{-}

[1]. The lowest available Fe was registered in soils of Panamarathupatti (0.9 mg kg^{-1}) block. The DTPA-Mn content in the soils of Salem district ranged from 0.2 to 84.1 mg kg^{-1} with a mean of 17.0 mg kg^{-1}. The highest mean Mn availability was recorded in Gangavalli (39.7 mg kg^{-1}) followed by Omalur (35.6 mg kg^{-1}), and Nangavalli (32.8 mg kg^{-1}) blocks while the lowest mean DTPA-Mn was observed in the soils of Idappadi block (3.6 mg kg^{-1}). The mean values of soil available micronutrients status (mg kg^{-1}) in different blocks of Salem district is shown in table 2.The DTPA-Zn status of the soils ranged from 0.2 to 17.5 mg kg^{-1} with a mean of 1.6 mg kg^{-1}. The mean value showed that available Zn was the highest in Yercaud (4.3 mg kg^{-1}) followed by Salem and Kolathur blocks (2.2 mg kg^{-1}). The lowest mean available Zn content was observed in Konganapuram (0.9 mg kg^{-1}).

Table 1: Mean Values of Soil Properties in Different Blocks of Salem District

S. No.	Name of the Block	Soil Properties			
		pH	EC (dS m^{-1})	OC (g kg^{-1})	$CaCO_3$ (%)
1	Attur	8.06	0.25	3.3	6.8
2	Gangavalli	8.02	0.34	3.6	5.8
3	Peddanaickenpalayam	8.06	0.27	3.4	6.3
4	Talaivasal	8.02	0.27	3.8	5.7
5	Kolathur	8.03	0.22	3.0	3.9
6	Mecheri	8.05	0.23	3.0	4.0
7	Nangavalli	8.01	0.24	3.2	5.1
8	Kadaiyampatty	7.97	0.22	2.9	3.4
9	Omalur	7.83	0.23	3.2	6.5
10	Taramangalam	7.96	0.24	3.0	5.4
11	Ayodhiyapattinam	8.05	0.15	2.9	10.1
12	Panamarathupatti	8.02	0.14	3.0	9.1
13	Salem	7.71	0.27	3.8	5.7
14	Valapady	7.67	0.18	2.5	9.6
15	Veerapandi	8.05	0.21	2.6	12.8
16	Idappadi	7.91	0.26	3.0	8.4
17	Konganapuram	7.99	0.26	3.1	8.4
18	Macdonalds Choultry	7.98	0.27	3.0	8.9
19	Sangagiri	7.96	0.27	3.3	10.5
20	Yercaud	6.44	0.26	3.1	2.2
District		**7.97**	**0.24**	**3.1**	**6.9**

The DTPA-extractable Cu status of the soils of Salem district ranged from 0.2 to 20.9 mg kg^{-1} with a mean of 2.5 mg kg^{-1}. The mean values showed that the highest available Cu was recorded in Salem (4.2 mg kg^{-1}) followed by Kolathur and Yercaud (3.2 mg kg^{-1}) blocks The highest available B content was registered in the soils of Kadaiyampatti (4.6 mg kg^{-1}) with a mean of 2.92 mg kg^{-1} followed by Macdonalds Choultry block (4.4 mg kg^{-1}).

Table 2: Mean Values of Soil Available Micronutrients Status (Mg kg^{-1}) in Different Blocks of Salem District

S. No.	Name of the Block	Available Micronutrient Status (mg kg^{-1})				
		Fe	Mn	Cu	Zn	B
1	Attur	9.0	13.9	2.5	1.4	1.73
2	Gangavalli	19.3	39.7	2.3	1.4	1.31
3	Peddanaickenpalayam	20.1	20.2	2.8	1.5	0.37
4	Talaivasal	20.1	12.8	2.6	1.5	0.89
5	Kolathur	10.2	18.2	3.2	2.2	1.13
6	Mecheri	10.1	10.1	1.3	1.2	0.99
7	Nangavalli	15.7	32.8	1.1	2.1	0.47
8	Kadaiyampatty	7.5	14.9	2.9	1.7	2.92

Table 2: Contd.,						
9	Omalur	12.1	35.6	2.3	1.5	1.00
10	Taramangalam	8.3	4.5	2.9	1.3	0.44
11	Ayodhiyapattinam	9.3	13.1	2.7	1.7	0.39
12	Panamarathupatti	8.8	24.1	3.1	1.5	0.53
13	Salem	10.4	9.9	4.2	2.2	0.95
14	Valapady	16.8	18.5	1.9	1.3	1.25
15	Veerapandi	10.7	17.6	2.7	1.3	0.38
16	Idappadi	8.3	3.6	2.7	1.1	0.66
17	Konganapuram	11.4	6.6	1.1	0.9	0.49
18	Macdonalds Choultry	10.6	4.4	1.7	1.2	0.69
19	Sangagiri	11.2	7.2	2.0	1.1	0.52
20	Yercaud	56.8	31.7	3.2	4.3	0.75
District		**14.3**	**17.0**	**2.5**	**1.6**	**0.89**

Correlation Studies

The results revealed that the soil reaction (pH) of Salem district had significant negative correlation with availability of Fe. This might be attributed to the formation of insoluble oxides of Fe at higher pH. Significant effect of pH on iron availability has been reported by Patil *et al*. (2003) and Sharma *et al.* (2003). The reduction in availability of iron with increasing pH might also be attributed to conversion of Fe^{2+} to Fe $^{3+}$ ions. Table 3 shows the result of correlation studies of the soil samples collected from Salem district. A significant negative correlation (r=-0.175**) between pH and available Zn could be observed. The solubility of native forms of Zn is highly pH dependent and decreased by a factor of 100 per cent per unit raise in pH (Lindsay, 1972).

The availability of Mn (r=-0.084**) showed significant negative correlation with soil pH. Manganese may get complexed by organic matter, manganese oxides are formed, and precipitation of manganese by calcium carbonate. Disassociation of these complexes is dependent on pH; the lower the pH, the more Mn available (Smiley *et al*., 1986).For the entire Salem district B availability showed a significant positive correlation with pH (r=0.063**). Berger and Troug (1946) reported that availability of B was comparatively more between pH 6.0 and 8.0 and it decreases below and above that range. The results of Nazif *et al*. (2006) and Anitha *et al.* (2013) also indicated a positive relationship of available B with soil reaction.

Table 3: Simple Correlation Coefficients between Available Micronutrients and Soil Characteristics

Soil Properties	Correlation Coefficients				
	Fe	Mn	Cu	Zn	B
pH	-0.254**	-0.084**	-0.030	-0.175**	0.063**
EC	0.102**	-0.006	-0.053*	-0.045	0.079**
OC	0.038	0.052*	-0.010	0.001	0.003
Free $CaCO_3$	-0.114**	-0.083**	0.061*	-0.027	-0.127**

The significant positive correlation between EC and available Fe was noticed in Salem district (r=0.102**). Maji *et al.* (1993) and Choudhary *et al.* (2012) have also observed positive correlation between EC and Fe availability. EC showed a significant and positive correlation with available B (r=0.079**). Similar results were shown by Arora and Chahal (2007). Available Cu showed a significant negative correlation with EC (r=-0.053*). Similar results were observed by Sahoo *et al.* (2003).

A significant and positive correlation was found between OC content and Mn availability (r=0.052*). The quality and quantity make up of organic matter influences Mn availability in the soils. Organic matter indirectly brings about Mn transformation due to the release of an array of organic compounds during the decomposition. Organic colloids can retain Mn by complex formation (Bassirani *et al.,* 2011). The free $CaCO_3$ content exhibited significant negative correlation with Fe (r=-0.114**), Mn (r=-0.083**) and B (r=-0.127**). Significant positive correlation of available Cu (r=0.061*) was observed with $CaCO_3$. The negative effect of $CaCO_3$ on the availability of Fe in Indo Gangetic plain was reported by Sidhu and Sharma (2010). The same trend of antagonism was also observed by Yadav and Meena (2009) observed that DTPA-Mn content showed significant negative correlation with $CaCO_3$. Singh *et al.* (1997) reported a positive correlation between DTPA-Cu and $CaCO_3$. In young alluvial soils of Bihar, the incidence of B deficiency was higher (47%) in calcareous soils as compared to non calcareous soils (Sakal and Singh, 1999).

CONCLUSIONS

From the study conducted in soils of Salem district it is found that soil properties such as pH, EC, organic carbon, and free calcium carbonate content have great influence on availability of micronutrients in soil. Soil reaction (pH) was significantly and positively related with B, significantly and negatively related with Fe and Mn where as non significantly and negatively related with Cu. Electrical conductivity was significantly and positively related with Fe and B and negatively related with Zn, Mn and Cu. Organic carbon significant positive relation with Mn while non significantly positively related with Fe, Zn and B and non significantly negatively correlated with Cu. Free calcium carbonate showed significant negative correlation with Fe, Mn and B, and non significantly negatively correlated with Zn. However significant positive correlation existed with Cu.

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